

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 10/689,198

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Applicant: Joseph D. Rainville et al.

Group Art Unit: 1795

Examiner: Alix Elizabeth Echelmeyer

Title: REGENERATIVE COMPRESSOR MOTOR CONTROL
FOR A FUEL CELL POWER SYSTEM

Attorney Docket: 8450G-000213 (General Motors Docket No. GP-303508)

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

RESPONSE UNDER 37C.F.R § 1.111

Sir:

In response to the Office Action mailed October 30, 2008, please enter these claim amendments and consider the remarks set forth below.

Amendments to the Claims begin on page 2 of this paper.

Remarks begin on page 5 of this paper.

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1-9. (Cancelled)

10. (Currently amended) A fuel cell system, comprising:

a fuel cell that processes an oxidant to produce electrical energy;

a variable capacity compressor system that supplies said oxidant to said fuel cell and that
during operation of the fuel cell system, supplies said oxidant by operating in a mode selected
from ~~is operable~~ in a normal mode below a threshold rate of 40%/s change in capacity and a
rapid transient mode selected from an upward and downward variation at or above the threshold
rate, said variable capacity compressor system comprising:

a compressor that compresses said oxidant; and

a compressor motor that drives said compressor

a controller that monitors a power demand from said fuel cell and that selects a power
source for said compressor motor, said power source being either a main power source when
operating in said normal mode or a supplemental power source when operating in said rapid
transient mode which is upward wherein said supplemental power source is selected from
capacitors and supercapacitors and wherein said controller controls charging of said
supplemental power source comprising regenerative braking of the compressor motor that
converts mechanical energy into charging current.

11--16.(Cancelled)

17. (Previously presented) The fuel cell system of claim 10 wherein charging further comprises using power generated by said fuel cell.

18--19. (Cancelled)

20. (Original) The fuel cell system of claim 10 wherein said controller shifts said variable capacity compressor between said normal mode and said rapid transient mode based on said power demand.

21. (Currently amended) A method of operating a fuel cell system comprising a variable capacity compressor system, comprising a variable capacity compressor that supplies an oxidant to fuel cells of the fuel cell system while the fuel cell system operates and a compressor motor that drives the compressor, the method comprising:

operating said variable capacity compressor in a normal mode at a first capacity of the fuel cell system to produce electrical power;

powering the compressor motor from a main power source during said normal mode;

adjusting said variable capacity compressor from said first capacity to a second capacity of the fuel cell system to produce electrical power when in a rapid transient mode at or above a threshold rate of 40%/s change in capacity; and

when in said rapid transient mode either:

a) powering the compressor motor from a supplemental power source when said rapid transient mode is an upward rapid transient mode, or

b) regeneratively braking the compressor motor to produce charging current for said supplemental power source when operating in said rapid transient mode which is a downward rapid transient mode.

22. (Original) The method of claim 21 wherein said second capacity is greater than said first capacity when operating in said upward rapid transient mode.

23. (Original) The method of claim 21 wherein said second capacity is less than said first capacity wherein operating in said downward rapid transient mode.

24. (Original) The method of claim 21 wherein said supplemental power source is a capacitor.

25. (Original) The method of claim 21 further comprising charging said supplemental power source during said normal mode.

26. (Currently amended) The method of claim 21 further comprising using power from said supplemental power source to increase speed of the compressor motor when in said upward rapid transient mode.

REMARKS

Claims 10, 17, and 20-26 remain pending. Independent claims 10 and 21 have been amended as suggested by the Examiner to indicate that the rate refers to change in capacity of the compressor. The amendment is supported by the specification at paragraphs [0019]-[0020] and also by the claims themselves (“variable capacity compressor”).

Applicants have also amended claims 10, 21, and 26 to clarify that the motor referred to in the claims is the *compressor* motor, not the vehicle motor. In addition, while Applicants believe it is inherent in fuel cell systems, Applicants have amended the independent claims to make it explicit that the compressor supplies oxidant to the fuel cells as long as the fuel cell system operates. Applicants believed this is an inherent feature of fuel cell systems, since without the oxidant there is no reaction, thus no electricity generated, thus the fuel cell system ceases operation. However, in light of the Examiner’s comment that the claims “do not include limitations to the constant running of either the fuel cell system or the compressor” on page 7 of the Office Action, and in an abundance of caution that the Examiner should understand that the compressor supplies the oxidant the fuel cell needs to operate, Applicants have introduced this amendment.

Applicants appreciate the Examiner’s careful consideration of the claims and respond to the rejections as follows.

Rejections Under 35 U.S.C. § 112, Second Paragraph

Claims 10, 17, and 20-26 stand rejected as allegedly indefinite in the phrase “threshold rate below 40%/s.” The Office Action states that it is unclear because the claims do not state that

the rate refers to change in capacity of the compressor. Applicants have amended independent claims 10 and 21 to make this explicit.

Applicants believe that this amendment overcomes the rejection and respectfully request reconsideration of the claims as amended.

Rejection Under 35 U.S.C. § 103(a) over Lahiff in View of Arnold et al.

10, 17, and 20-26 stand rejected as unpatentable over Lahiff in view of Arnold et al. Applicants respectfully traverse the rejection as it applies to the amended claims 1 and 10 and request reconsideration of the claims.

Applicants have carefully considered the objections raised by the Examiner to their argument in the last response filed and, having amended the claims, believe that the claims overcome the issues raised.

First, the claims require that it is the compressor motor that is regeneratively braked. The Lahiff patent teaches that its vehicle motor is regeneratively braked. Paragraph [0033]. As taught by the Lahiff patent (and known in the art), regenerative braking of the vehicle's motor converts the kinetic energy of the vehicle into electric energy. Paragraph [0004].

In contrast, Applicants claims require regenerative braking of the compressor motor. This action is entirely independent of the vehicle's kinetic energy. Applicants further note that it is motor 34 of the Lahiff drive train that is regeneratively braked, not compressor motor 78. Figs. 3 & 6; paragraphs [0031] (distinguishing fuel cell power system 10 and motor system 28), [0033] (motor 34 drives wheels f vehicle), [0037] (regenerative braking of motor 34)[0042] (same). Thus, the Lahiff patent fails to disclose any regenerative braking of a compressor motor.

The Lahiff teaches that during regenerative braking, the compressor of the fuel cell system is being operated to dissipate electrical energy, not to generate it. Abstract. Thus, the Lahiff patent teaches away from the modifications that would be required to arrive at Applicants' invention.

The rejection relies on the Arnold patent to teach a variable speed compressor. The Arnold patent describes an internal combustion engine turbocharger system that uses an exhaust-driven turbine to generate electricity to drive a compressor to boost power. Col. 2, ll. 42-67. Arnold describes using its compressor intermittently to provide bursts of power, e.g. for ten seconds, in the paragraph bridging columns 5 and 6. In this way, the Arnold compressor is either operating or it is not. The Arnold reference does not teach a compressor that is used in a normal mode with intermittent rapid transient upward and downward modes, but instead teaches a compressor used intermittently. Top of column 6. This is in contrast to operation of a compressor in a fuel cell system, which must supply the oxidant that the fuel cells require to work. Therefore, there is no reason to modify the Lahiff fuel cell system with the Arnold compressor system because (1) the Arnold intermittent bursts of compressed air will wreak havoc with operation of the Lahiff fuel cell system and (2) the Arnold compressor, which derives its energy from exhaust from an internal combustion engine, are not going to work where no internal combustion engine is present.

The Examiner refers to "use of stored power . . . and then switching back to the on-line power . . . for normal operation" in column 6, lines 7 to 20 of Arnold. Office Action, pages 6-7. This passage still teaches that the compressor is operated only intermittently, and that, of its two possible power sources, one is the turbine.

Because of these deficiencies of the combined references cited in rejection,
reconsideration and allowance of the claims are thus respectfully requested.

Conclusion

It is believed that all of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action, and as such, the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

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